CURRENT FUEL CELL COAL-BASED SYSTEMS (FCCBS) PROJECTS

The projects will be conducted by three Industry Teams - General Electric (GE) Hybrid Power Generations Systems (HPGS), LLC, Siemens Power Generation (SPG), and FuelCell Energy (FCE). The three teams will research, develop, and demonstrate fuel cell technologies that can support power generation systems >100 MWe capacity.

General Electric - GE HPGS, located in Torrance, CA, is leading the development team that includes GE Energy units in Greenville, SC and Schenectady, NY, the GE Global Research Center in Niskayuna, NY, the University of South Carolina in Columbia, SC and Pacific Northwest National Laboratory in Richland, WA. This team will develop an integrated gasification fuel cell (IGFC) system that merges GE's SECA-based planar SOFC, gas turbine, and recently acquired (from ChevronTexaco) coal gasification technologies. To achieve this objective, GE is developing high-performance, low-cost SOFC stacks suitable for hybridization with a gas turbine. The early effort focuses on the resolution of a number of identified SOFC barrier issues, to include:

- Stack design: Fuel cell stacks based on the current SECA design must be evaluated for design features and performance required for hybridized (i.e., fuel cells + turbine) coal gas applications. GE will focus on pressurized coal gas operation of stacks incorporating large-area cells. Stack design evaluation and modification will consider key factors such as temperature and flow distribution, cost, manufacturability, and mechanical and sealing properties.

- Fabrication/manufacturing scale-up: Cells of increasing footprint will be fabricated by the tape calendering process and characterized for physical, mechanical, chemical, and microstructural properties. The influence of various fabrication process parameters must be studied, modified and optimized for fabricating large-area cells with high yields.

- Hybridized coal gas operation: Stacks must be tested to evaluate electrochemical and other performance characteristics under hybridized (fuel cell + turbine) system conditions, fueled by coal synthesis gas. This work includes the collection of performance maps under different pressures and operating conditions. Operation guidelines and operating procedures will be developed for operating stacks under hybridized coal gas conditions.

- Degradation: Stack performance degradation under hybridized coal gas conditions must be investigated, to include:
  - the long-term testing of stacks under different pressures and operating conditions to assess degradation rates;
  - the effects of pressure on the cathode performance and performance degradation; and
  - the effects of pressure on metallic interconnects with respect to corrosion/oxidation properties and SOFC chromium poisoning issues.

The results will be used to elucidate degradation mechanisms and to develop and implement approaches to mitigate degradation rates under pressurized conditions. The Pacific Northwest National Laboratory (PNNL) and the University of South Carolina are participating in the degradation study effort.

Siemens Power Generation - SPG is partnering with ConocoPhillips and Air Products and Chemicals, Inc. to develop large-scale fuel cell systems based upon their in-house gas turbine and SECA modified tubular SOFC technologies. ConocoPhillips will provide coal gasification expertise. In addition, the baseline design incorporates an ion transport membrane (ITM) oxygen air separation unit (ASU) from Air Products, offering system efficiency advantages over traditional ASUs. Initial project tasks focus on:

- System design: A conceptual design and feasibility analysis of the preferred cycle concept will be performed for both a large baseline power plant [>100 MWe] and a multi- MWe POC demonstration system.

- Cell development: Cell development work focuses on the advancement of the existing SECA-developed DELTA-9 SOFC cell, to include analysis, design optimization, and scale-up to its largest practical size. This goal will be supported by the associated development of viable cell manufacturing processes and the parametric testing of cell performance. This work aims to optimize cell geometry and configuration from the perspectives of in-system performance, reliability and cost.

- Stack and SOFC module development: The analysis, design and development of a fuel cell stack with segregated anode and cathode exit gases will be performed. This effort will culminate in a test of a thermally self-sustaining fuel cell stack at power system operating pressure, fueled with simulated coal syngas. Concurrently, the analysis and preliminary design of the module aggregating a number of fuel cell stacks will be conducted.

FuelCell Energy – FCE is teaming with VersaPower Systems (VPS), Nexant, and Gas Technology Institute (GTI) to develop large-scale syngas-fueled fuel cell systems. VPS, a developer of SOFC technology, is advancing high power density and reliable cells and stacks for use in the FCE system. Nexant and GTI have both been involved in the development of efficient, cost-effective coal gasification and power generation technologies where increased emphasis is placed on reducing and controlling environmental emissions. Initial project tasks focus on:

- Cell development: Both fabrication and operational issues related to scale-up of SOFC active area to 900 cm^2 will be addressed. A unique cell arrangement, "C-plate", will extend the planar cell area in each repeat unit further to 3600 cm^2.

- Stack/Module development: The technical approach focuses on an innovative SOFC stack configuration incorporating newly-developed SOFC seals and a novel implementation of a SOFC module clustering concept.

- System design: An innovative patented system concept will be evaluated in the design of multi-MWe POC and 100+ MWe power plants. The proffered cycle integrates the SOFC modules with an indirectly heated gas turbine. The proposed system has the flexibility of using both atmospheric as well as pressurized fuel cells.